Space Launch System Base Heating Test: Environments and Base Flow Physics

Manish Mehta*, Kyle S. Knox†, C. Mark Seaford‡
NASA Marshall Space Flight Center, Huntsville, Alabama, 35812
Aaron T. Dufrene§
CUBRC Inc., Buffalo, New York, 14225

The NASA Space Launch System (SLS) vehicle is composed of four RS-25 liquid oxygen-hydrogen rocket engines in the core-stage and two 5-segment solid rocket boosters and as a result six hot supersonic plumes interact within the aft section of the vehicle during flight. Due to the complex nature of rocket plume-induced flows within the launch vehicle base during ascent and a new vehicle configuration, sub-scale wind tunnel testing is required to reduce SLS base convective environment uncertainty and design risk levels. This hot-fire test program was conducted at the CUBRC Large Energy National Shock (LENS) II short-duration test facility to simulate flight from altitudes of 50 kft to 210 kft. The test program is a challenging and innovative effort that has not been attempted in 40+ years for a NASA vehicle. This presentation discusses the various trends of base convective heat flux and pressure as a function of altitude at various locations within the core-stage and booster base regions of the two-percent SLS wind tunnel model. In-depth understanding of the base flow physics is presented using the test data, infrared high-speed imaging and theory. The normalized test design environments are compared to various NASA semi-empirical numerical models to determine exceedance and conservatism of the flight scaled test-derived base design environments. Brief discussion of thermal impact to the launch vehicle base components is also presented.

*Aerospace Engineer, Aerothermodynamics, Aerosciences Branch, MS 3421/EV33, AIAA Member
†Aerospace Engineer, Aerothermodynamics, Qualis-Corporation, MS 3416/EV33, AIAA Member
‡Aerospace Engineer, Aerothermodynamics, Aerosciences Branch, MS 3422/EV33, AIAA Member
§Senior Research Scientist, Aerothermal and Aero-Optics Evaluation Center, AIAA Member